

The Role of Surgery and Hyperalimentation in Therapy of Gastrointestinal-Cutaneous Fistulae

ALFONSO AGUIRRE, M.D., JOSEF E. FISCHER, M.D.,
CLAUDE E. WELCH, M.D.

Thirty-eight patients with external gastrointestinal fistulas arising from different levels of the gastrointestinal tract, observed and treated at the Massachusetts General Hospital, from December 1970 to April 1973, are analyzed. Surgical complications were the causes of fistulization in 77% of the cases. The treatment program included parenteral nutrition through a subclavian line in all cases. The 38 patients were fed parenterally for a total of 2311 days. Spontaneous fistula closure occurred in only 11 of the 38 patients. Surgical procedures were necessary in 71.05% of the cases to control fistula complications or persistent fistula drainage. Operative success rate was 70.4%. Parenteral nutrition effects on metabolic parameters, fistula secretion, nutritional status, morbidity and mortality of fistulas are discussed. Parenteral nutrition hazards are also presented. Overall mortality in this series was 21%. Roles of parenteral nutrition and surgery in the total management of external gastrointestinal fistulas are suggested.

ALL PREVIOUS REPORTS on the management of gastrointestinal-cutaneous fistulae have demonstrated the gravity of this condition with overall mortalities in different levels of the gastrointestinal tract ranging from 20% to 62%. Treatment in the past has generally consisted of conservative measures, followed, in case of failure, by surgical attack on the fistulae in an attempt to stabilize the precarious metabolic and nutritional state of these patients.^{1,3,5,7,8,10} The introduction and standardization of parenteral nutrition^{2,4,6,10} has improved considerably the treatment and prognosis of patients with gastrointestinal-cutaneous fistulae, since prior studies suggested that malnutrition and electrolyte imbalance were among the main causes of death.^{1,3,8,12}

In 1960, a previous report from this institution placed

*From the Hyperalimentation Unit, Department of Surgery,
Harvard Medical School and
Massachusetts General Hospital,
Boston, Massachusetts 02114*

the mortality range for external gastrointestinal fistulae between 16% in colonic fistulae and 62% in gastroduodenal fistulae.³

It has been our impression that since the introduction of total parenteral nutrition, the mortality in gastrointestinal fistulae in this hospital over the past three years has decreased remarkably. To be sure, not all of the decrease in mortality has been due to total parenteral nutrition, for there have been other advances in total patient care since the early 1960's. Recently, McPhayden and Dudrick⁶ reported a series of 62 patients with internal and external gastrointestinal fistulae treated with hyperalimentation, obtaining spontaneous fistula closure in 70.5% with an overall mortality as low as 6.45%. Our experience suggests that spontaneous closure is less common, particularly in the presence of certain features which we have attempted to identify systematically, such as lack of continuity of bowel, presence of intra-abdominal abscesses, and distal obstruction which tend to point to operation as the only means of obtaining closure of these fistulae. This report represents an ongoing study of patients with gastrointestinal-cutaneous fistulae in this institution and is at variance with the paper of McPhayden and Dudrick perhaps because of an apparently different patient population.

Since 1970, when the Hyperalimentation Unit at the Massachusetts General Hospital was formalized, until April of 1973, 38 patients with external gastrointestinal fistulae have been treated on the Surgical Services. Total parenteral nutrition has been an integral part of their treatment program. In most cases total parenteral nu-

Presented at the Annual Meeting of the American Surgical Association, Colorado Springs, Colorado, May 1-3, 1974.

Reprint requests: Josef E. Fischer, M.D.

trition of long duration was maintained prior to and after surgery. The following study will attempt to document the respective roles of hyperalimentation and operative surgery in the therapy of these important complications.

Clinical Material

Thirty-eight patients, 18 females and 20 males, with an age range 17–77 years were treated. Most of the patients were in the 5th, 6th, and 7th decades. One had an esophageal fistula, six had gastroduodenal, seven jejunal, 19 ileal, and five had the fistula in the colorectal portion of the gastrointestinal tract. In two cases of ileocutaneous fistula and in one case of colocutaneous fistula, internal fistulae were associated. Most of the patients were extremely ill. Twelve of the 38 patients originally came from other hospitals with established fistulae and in three instances after secondary surgical procedures had failed to correct them. Inflammatory bowel disease was the main original cause (Table 1) of spontaneous external fistulae of the gastrointestinal tract. Surgical procedures attempted for the treatment of such inflammatory bowel disease were the chief etiological factors of postoperative fistulae. Thus surgical complications or anastomotic breakdown were causative in 77% of the fistulae (Table 2).

Fistula Drainage

The amounts of fistula secretion were variable, with drainages ranging 50–4000 cc daily, but predominantly high in most cases. The average output was 800 cc for one esophageal fistula, 600 cc/day for gastroduodenal fistulae, 904 cc for jejunal, 763 cc for ileal, and 387 cc for colorectal fistulae. The high drainage in most cases led not only to malnutrition (a common accompaniment of such fistulae) but to serious electrolyte imbalance.

Treatment Program

As soon as the fistula was recognized or the patient received in transfer from another hospital, a subclavian line was placed and oral intake omitted. Total parenteral nutrition was carried out by a subclavian or internal jugular catheter according to a protocol previously described.⁴ In addition, all patients received blood and

TABLE 1. *Fistulae and Primary Disease*

Fistula Location	Number of Patients	Primary Disease
Esophageal	1	Surgical injury-vagotomy for ulcer
Gastric	1	Abdominal contusion
	1	Gastric ulcer
	1	Postop chronic fistula
Duodenal	1	Duodenal ulcer
	1	Cholecystitis
	1	Choledocolithiasis
Jejunal	1	Pancreatitis
	1	Pancreatic cancer
	1	Granulomatous colitis
	1	Ulcerative colitis
	1	Diverticulitis
	1	Septic chronic peritonitis
	1	Ulcer disease
Ileal	1	Familial congenital polyposis
	2	Bowel obstruction
	3	Colonic cancer
	5	Regional enteritis
	3	Ulcerative colitis
	1	Granulomatous colitis
	3	Diverticulitis
	1	Cancer of the bladder
Colonic and Rectal	1	Regional enteritis
	1	Ulcerative colitis
	2	Cancer of rectum
	1	Peritonitis
Total	38	

albumin infusions as well as electrolytes, skin care and sump drainage of fistulae.

The mean duration of lack of oral intake in these patients was approximately 40 days with 21 days in the esophageal fistula, 27.5 days in the gastroduodenal group, 39.8 in the jejunal group, 47.5 in the ileal group and 37.4 in the colorectal fistulae. The average duration of parenteral nutrition was 21 days for the patient with esophageal fistula, 36.5 days for gastroduodenal fistulae, 86.6 for jejunal, 69.12 for ileal, and 50 days for colorectal fistulae. A variety of solutions was used and the total duration of time for which all the patients received hyperalimentation was 2311 days. Solutions used were protein hydrolysate in 32 cases, a synthetic amino acid

TABLE 2. *Fistulae and Etiological Factor*

	Esophageal	Gastric	Duodenal	Jejunal	Ileal	Colonic/Rectal
Surgical Complication						
Anastomotic breakdown		3	2	2	3	2
Injury	1			4	11	1
Persistent Gastrostomy Drain		1				
Inflammatory Disease				1	3	1
Undetermined					2	1
Total	1	4	2	7	19	5

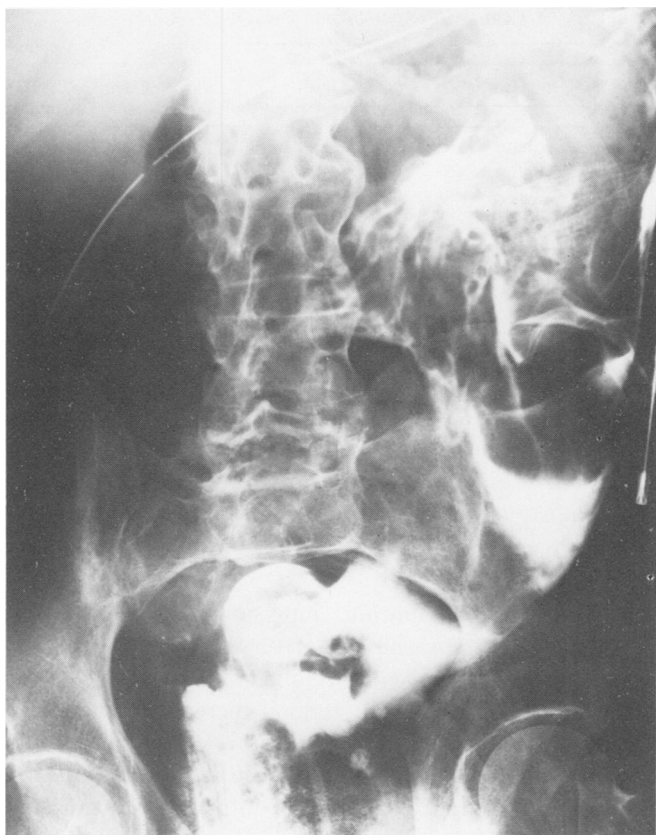


FIG. 1. Extensive intra-abdominal abscesses, an example of which is given, are often related to lack of spontaneous closure of fistulae with hyperalimentation. In this case the sinogram demonstrates an extensive abscess following total colectomy for granulomatous colitis, starting in the left upper quadrant, communicating with another sinus and fistula in the left lower quadrant and exiting from the perineal wound. Operation was required to close this patient's fistula.

protein source and dextrose in four cases (Freamine® intralipid®* in another and mixture of essential amino acids and hypertonic dextrose (Freamine E®†) in one patient with impaired renal function. The daily rate of calories given ranged between 2,000 (in a patient with renal failure) and 4,500. Between nine and 20 g of nitrogen were administered in 24 hours. Eighty-five subclavian catheters were used in 38 patients, the average duration per catheter being 27.9 days. Most of the catheters were changed at various intervals because of suspected catheter sepsis, ultimately not confirmed by blood or catheter tip culture.

As soon as the patient was physically able to tolerate an hour session of fluoroscopy, he was fluoroscoped by the radiologist and the responsible surgeon with thin catheters and hypaque inserted into all identifiable orifices. The purpose of such fluoroscopy with both the

surgeon and the radiologist present was to identify: 1) the site of the fistulae; 2) whether the bowel was in continuity; 3) whether there was any distal obstruction; 4) the nature of the bowel immediately adjacent to the fistula; and 5) the presence or absence of an intra-abdominal abscess either in conjunction with or immediate adjacent to or remote from the site of the gastrointestinal cutaneous fistula. At this time it was at least possible to get a preliminary idea of the anatomical arrangement. Extensive intra-abdominal abscesses (Fig. 1) or lack of continuity of bowel (Fig. 2) (i.e., the fistulagram failed to visualize both ends of the bowel) proved to be the most significant factors in preventing spontaneous closure. Under the circumstances, attempts to obtain spontaneous closure of fistulae with prolonged hyperalimentation failed. It soon became clear that a certain number of fistulae would not close spontaneously. In the later stages of the study, the responsible surgeon often could identify these cases from the initial fistulagram.

Results

Spontaneous Closure

Only 11 of the 38 patients closed their fistulae spontaneously. One esophageal fistula closed in 17 days. One had a gastric fistula which closed in 61 days, two had duodenal fistulae which closed in ten and 15 days, three had jejunal fistulae which closed in 15, 16, and 40 days



FIG. 2. Lack of continuity of bowel as demonstrated on an upper GI Series. In this patient an end fistula caused by disruption of an anastomosis is seen. Bowel empties directly into an abscess cavity of rather large proportions and empties through a fistulous communication with the skin. Operation was, of course, required to close this fistula.

* Courtesy Dr. Manuel Tascon, Cutter Laboratories.

† Courtesy McGaw Laboratories, Glendale, California.

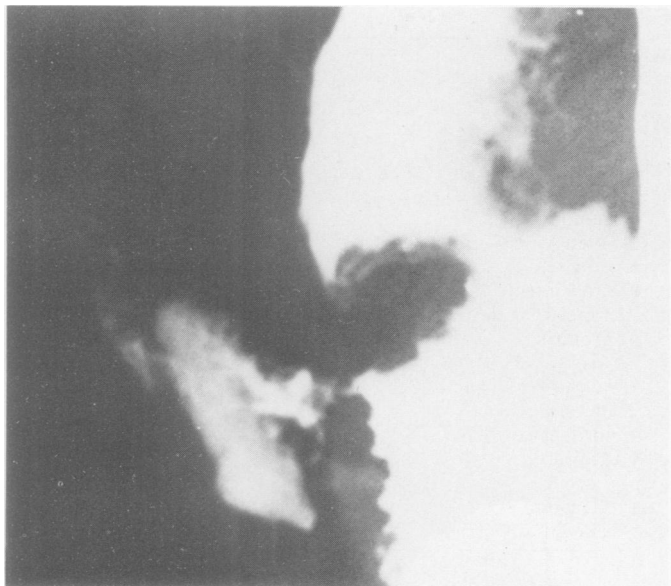


FIG. 3. An example of a fistula which can be expected to close spontaneously with hyperalimentation. The fistula is lateral and probably related to the end of a gastrojejunal anastomosis. Note that although there is an abscess in contiguity with the fistula, the abscess cavity is small. The fistula is lateral through the bowel and the bowel wall appears relatively normal, uninflamed and intact except for a small fistula. This fistula closed with 16 days of hyperalimentation.

and four had ileal fistulae which closed in 18, 21, 41 and 49 days (Fig. 4). The remainder of the patients required surgical intervention as a result of fistula complications, namely intraperitoneal abscesses, distal obstruction or persistent drainage. The indications for operation are summarized on Table 3. Persistent fistula drainage and intraperitoneal abscesses were by far the most important indications for surgical therapy. The operations per-

TABLE 3. *External Gastrointestinal Fistula Indication for Surgical Treatment*

	Gastroduodenal	Small Bowel	Large Bowel
Persistent fistula drainage		8	2
Intraperitoneal abscess	2	8	3
Intraperitoneal abscess plus obstruction		1	
Obstruction		1	
Bleeding	1		
Peritonitis		1	
Total	3	19	5

formed for fistula treatment are varied and are given in Table 4. The most common operations were direct attacks on the fistula with bowel resection plus primary anastomosis either with or without abscess drainage.

Metabolic Parameters

After hyperalimentation, most patients, even those requiring operation, showed a remarkable improvement in their appearance, with weight gain, apparently positive nitrogen balance and general increase in their feeling of well-being. Proteinemia improved in 24 patients, did not change significantly in 12, and diminished in two; this in spite of massive albumin infusions (as much as 200 g daily). The albumin/globulin ratio increased in 15, and remained unchanged in the others. In 31.5% of the patients comprising three gastroduodenal, one jejunal, seven ileal and one colorectal fistula, the amount of daily secretion decreased significantly after hyperalimentation was started. In the remainder of the cases, changes were insignificant. Fourteen patients gained an average of 10.18 lb during the entire course of hospitalization, including surgery. An additional ten lost 10.7 lb

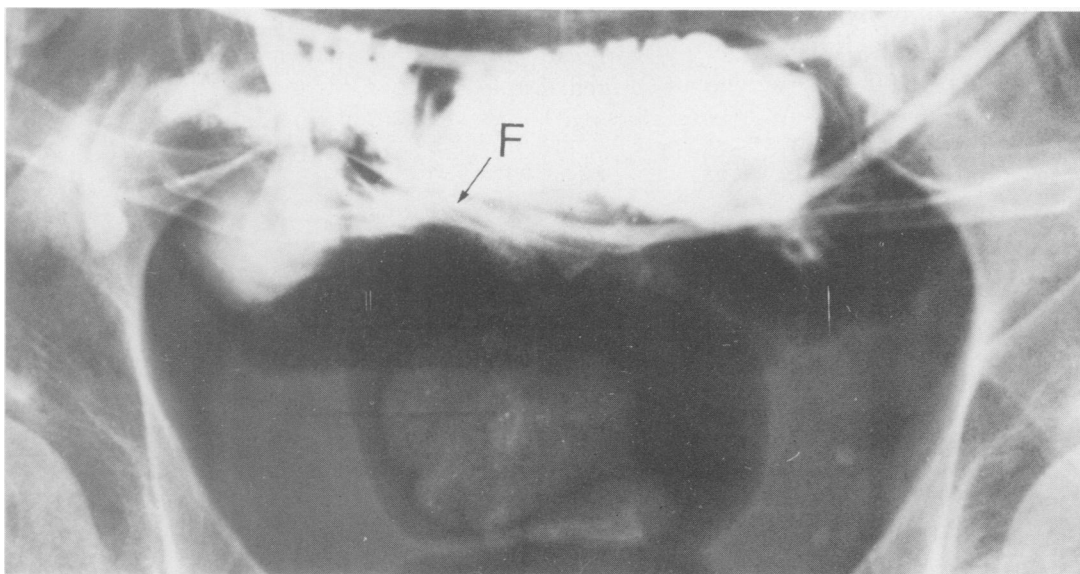


FIG. 4. Another example of a fistula which may be expected to close. Sinogram of an ileal fistula secondary to operative trauma. The bowel wall is intact and, again, is relatively uninflamed. The fistula is small as compared with the bowel circumference and appears to be entirely lateral. This fistula closed after 41 days of hyperalimentation.

TABLE 4. *Operations for Fistula Treatment*

Type of Procedure	Fistula Location		
	Gastric	Small Bowel	Large Bowel
1. Exploratory laparotomy	1		
2. Bowel resection plus			
External diversion		3	
Fistula closure		2	
Primary anastomosis		4	2
Primary anastomosis and abscess drainage		5	
Bypass procedure		1	1
3. Bypass procedures			
Partial		1	
Partial plus external diversion		1	
Total plus external diversion		1	
Total plus abscess drainage		1	
4. Fistula closure		2	
Plus abscess drainage	1	1	
5. Abscess drainage		1	2
Plus external diversion	1	1	1
Total	3	24	6

during their hospitalization; in the majority of those who lost weight, rampant sepsis ultimately leading to death was responsible for the weight loss. In others, massive anasarca was present when patients were admitted. A period of initial hyperalimentation was followed by massive diuresis so that with the fluid shifts in this group of patients weights were unreliable. A few patients, including those with uncontrollable sepsis, intraperitoneal abscesses or generalized peritonitis, did not gain weight despite the 5 or 6,000 cal infused daily and with an adequate level of insulin to prevent hyperglycemia. In an additional 13 patients, accurate weight measurements were not possible even when bed scales were used and these patients are not included in these calculations.

Certainly the metabolic advantages of hyperalimentation are quite apparent from this study. Hypoproteinemia was corrected in most of the patients but remained resistant in spite of massive albumin infusions in 14 of them. In contrast to the other reports⁶ the initiation of total parenteral nutrition and bowel rest did not result in decreased fistula drainage in approximately two-thirds of the patients. We were at a loss to explain this disparity in results, but presumably it reflects the greater incidence of surgical complications in this group of patients in which anastomotic disruption or end bowel fistulae draining into an abscess cavity were present.

Operative Results

In only two (one jejunal and one ileal fistula) of the operated patients who survived, the fistulae did not heal before hospital discharge. In both, a little drainage persisted for long periods after partial bypass in one and

TABLE 5. *Fistula Complications*

Complication	Gastroduodenal	Small Bowel		Large Bowel
Bled from fistula	2	2		
Anemia	1	6		
Malnutrition	3	15		3
Pulmonary complications				
Pneumonia	3	2		1
Pulmonary embolus				1
Infection				
Wound infection	3	15		2
Intraperitoneal abscess	1	9		3
Peritonitis		1		1
Sepsis	1	7		2
Electrolyte Imbalance	2	4		1
Obstruction		1		
Wound dehiscence	1	2		
Renal failure				1
Jaundice				1
Skin digestion			6	1
Depressive state			6	

total bypass in the other, but eventually closed. Bypass procedures have been reported as less effective than resection or external diversion in the surgical treatment of gastrointestinal fistulae.^{3,7,18} Thus, the overall operative success rate is 70.48% in the total number of patients. Five patients (one jejunal, three ileal, and one colonic fistula) had more than one operation for the treatment of complicated fistulae and two of them died with uncontrollable septic complications and re-fistulization. The other four deaths in the group were also patients who had intraperitoneal abscesses and who required operation, with bowel resection or bypass procedures performed in addition to drainage of abscesses; these anastomoses were done in a septic field. It should be emphasized that the principal indication for surgical procedures in the present series was intraperitoneal infection, related closely to the high incidence of inflammatory bowel disease among the primary diseases that predispose to fistula formation. Other factors could be the great proportion of patients referred with complicated fistulae after failure of medical or surgical therapy.

Complications of Parenteral Nutrition

Parenteral nutrition was not exempt of complications even though there were no serious consequences in this

TABLE 6. *Complications of Parenteral Nutrition*

Positive Catheter Culture	5
Clinical Catheter Sepsis	2
Elevation of SGOT LDH and ALK PHOS	2
Hypercalcemia (? Vit D Intox)	1
Hyperglycemia	1
Overhydration	1
Hematoma neck	1
Phlebitis SC vein	1
Subcutaneous emphysema	1

group of patients. In one patient, yeast septicemia was confirmed by catheter tip and blood cultures; the clinical picture subsided after the catheter removal and the patient has remained free of yeast sepsis over the past year of followup. In four other cases *staphylococcus epidermidis* or *staphylococcus aureus* was found in the catheter tip culture although this was not associated with a picture of catheter sepsis as defined in this institution⁹ nor did the septic focus appear to subside after catheter removal. A high incidence of positive catheter cultures in spite of the absence of clinical catheter sepsis has been noted by other observers.⁹ Other complications, metabolic or related to catheter insertion technique are listed in Table 6.

Deaths

Eight patients in this series died. One had a gastric fistula, which bled massively and two had jejunal fistulae complicated with multiple intra-abdominal abscesses, sepsis and malnutrition. Three had ileal fistulae with sepsis, multiple abscesses being the cause of death in two and bowel obstruction shortly after fistula closure the fatal complication in the third. Two other patients died of large bowel fistulae complicated by widespread intraperitoneal and extraperitoneal sepsis plus renal failure in one and fatal pulmonary embolism in the other.

Among the rest of the patients complications due to the fistulae were mainly infectious. Others, shown in Table 5 include electrolyte imbalance malnutrition, anemia, wound dehiscence, skin digestion and especially a common mental or depressive syndrome in these patients, some of whom had long months of hospitalization.

Discussion

Surgical complications following operations for complicated digestive disease continue to be the principal etiological factor in external gastrointestinal fistula formation.^{3,7,8,10} In our group of patients, as shown in Table 2, surgical injury in 17 cases and anastomotic break-

down in 12 caused 29 (77%) of the 38 fistulae. Inflammatory bowel disease, cancer and miscellaneous pathological conditions were the primary course in the rest of the patients.

The first goal in the treatment of these acutely-ill patients is the restoration of blood volume and the achievement of an accurate fluid and electrolyte balance. Blood transfusions and infusions of volumes of albumin are currently used as well as infusion of electrolyte solutions. Skin care is also a chief concern and wound inspection and drainage of any superficial abscess is performed when necessary. A subclavian catheter is placed immediately and total parenteral nutrition started, with the objective of an intake of 4000–5000 cal/24 hours.

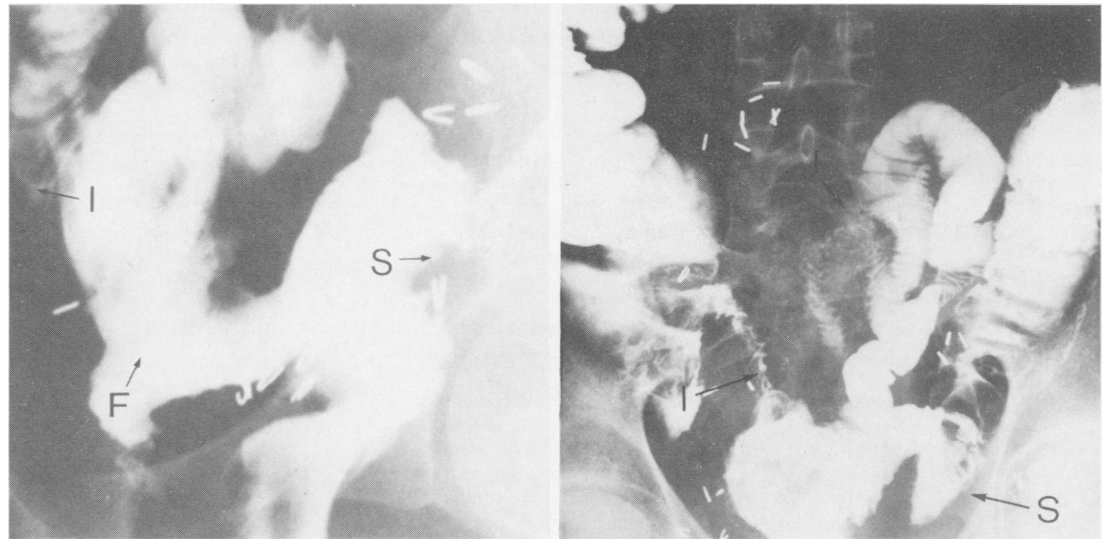
The most thorough evaluation of the gastrointestinal tract is desirable in order to establish the nature and location of the fistulous lesions. Sinograms with fluoroscopy are done as soon as the condition of the patient and the anatomical condition of the fistula make is possible. Of great importance is the collaboration of surgeon and radiologist when sinograms are performed, since their interpretation is often difficult. Dye injections, generally 60% Renografin® or Hypaque® in every single fistula opening are helpful in determining the characteristics of fistulous tracts and their connections with bowel loops. Barium or gastrografen exams, carefully done, are also helpful, either performed orally or per enema. If large abscess, distal obstruction or intestinal discontinuity are present, surgery should be done as soon as the patient's general condition makes it safe. Weight gain and improved appearance usually require a period of three to four weeks. In our series intraperitoneal abscesses were present in 14 cases and peritonitis in one. Distal obstruction obliged surgical treatment in only one instance (Fig. 5).

Persistent fistula drainage is another indication for operative management of fistulae. Although parenteral nutrition has obviated the need for surgical procedure to control massive fistula losses, ten of our patients re-



FIG. 5. A composite of x-rays in a fistula, which although lateral, did not close because of distal obstruction. Patient underwent multiple operations because of inflammatory bowel disease. Note that there is a great deal of inflammation of the surrounding small bowel. All of the bowel remains in continuity, distal obstruction necessitated operative correction.

FIG. 6. A spontaneous ileo-sigmoid cutaneous fistula in a patient who had undergone radical cystectomy and ileal loop as well as super voltage radiation one year earlier. This patient also had a small bowel fistula at the time of his previous surgery which had closed with hyperalimentation. Presentation was after cramps suggesting intestinal obstruction and the fistula presented through a lower abdominal wound. This closed after approximately 25 days of parenteral nutrition as well as an elemental diet yielding up to 6,000 cal/day. Inflammation remains around the rectum and the patient has intermittent low grade obstructive symptoms and may ultimately require diverting colostomy.



quired operation for persistent fistula drainage in spite of prolonged hyperalimentation, bowel rest and no abscess or distal obstruction (Table 3).

Following the above outlined program 11, or 30% (one esophageal, three gastric, three jejunal and four ileal fistulae) (Figs. 3, 4, 6, 7) spontaneously closed their fistulae. However, most of the rest of the patients who required operation showed remarkable clinical recovery before surgery was undertaken. It should be noted that pancreatic fistulae are not included in this series, but in our experience almost always close.

In 1960 Edmunds and associates reported that 78% of the overall deaths in 157 patients with external gastrointestinal fistulae were attributable to electrolyte and fluid imbalance, 61% to malnutrition and 67% to generalized peritonitis. In this series fluid and electrolyte

imbalance was not a direct cause of death and malnutrition had a secondary role as a contributory factor in only those patients submitted to two or three successive operations. Infection, however, was the main cause of death.

The importance of the nutritional status in the prognosis of patients with gastrointestinal fistulae has been well documented in previous reports by Chapman and associates, Sheldon and coworkers and recently by McPhayden and Dudrick and by Voitk *et al.*^{6,10,11} Hyperalimentation and bowel rest improve significantly the life expectancy in patients with external fistulae arising from the gastrointestinal tract although septic complications are still a serious threat. Our 21% overall mortality represents a significant improvement over the previous figures reported from this institution.^{3,12,13} The few com-

FIG. 7. An internal fistula associated with a ceecal-cutaneous fistula in a patient with Crohn's Disease. The fistula is seen to communicate between the cecum and the rectum. This fistula closed spontaneously with hyperalimentation only to reopen several times and resection was undertaken primarily at the patient's request. At the time of operation two fistulae to the rectum were found which were closed. Diverting colostomy was not used but a gastrostomy was placed and the patient kept NPO and on parenteral nutrition for two weeks following operation. A benign postoperative course resulted and the patient has been well since.

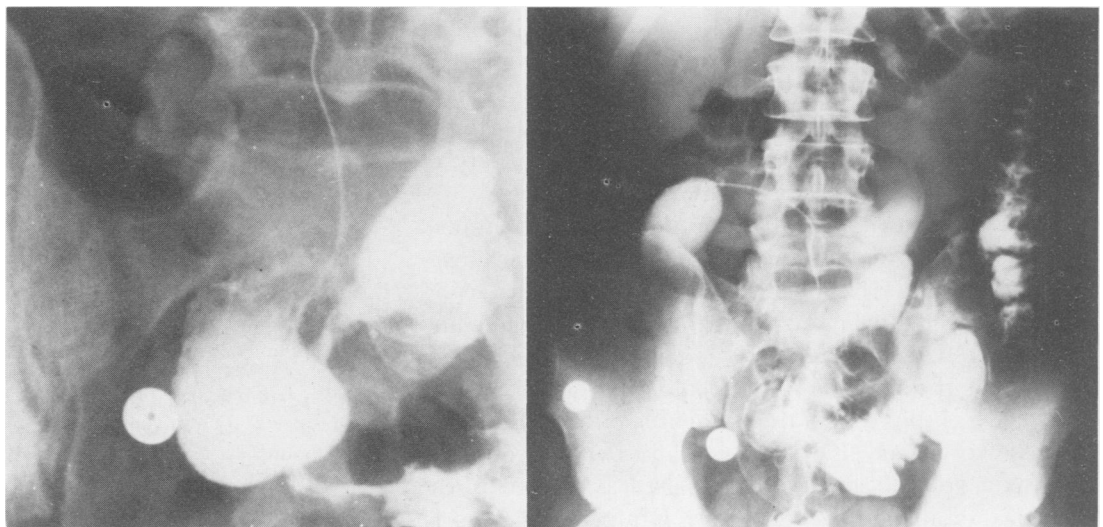


TABLE 7. *Surgical and Conservative Treatment of External Gastrointestinal Fistulae*

Author and Year	Number of Cases	Fistula Location (External fistulas)	Medical Management (% of cases)	Surgical Treatment (% of cases)	Overall Mortality
Edmunds, H., Williams, G. M., Welch, C. E. 1960	157	Gastroduodenal, small bowel, large bowel	22%	78%	44%
Lorenzo, G. A., Beal, J. M. 1969	18	Small bowel	8.6%	91.4%	30%
Nassos, T. P., Braasch, J. W. 1971	21	Duodenal, small bowel	33.4%	66.6%	22%
Sheldon, G. F., Gardiner, B. N., Way, L. W., Dunphy, J. E., 1971*	51	Gastroduodenal, small bowel, large bowel	36.3%	64.7%	12%
Roback, S. A., Nicoloff, D. M. 1972	55	Small bowel	40%	60%	30%
McPhayden, B. V., Dudrick, S. J. 1973*	61	Gastroduodenal, small bowel, large bowel	81.9%	18.3%	6.5%
This paper 1974*	38	Gastroduodenal, small bowel, large bowel	29.0%	71.1%	21%

* Parenteral nutrition was used.

plications related to intravenous nutrition in our patients did not have great importance in the clinical course but have to be considered in view of their potential significance.

While we would agree with all who have emphasized the nutritional needs of patients with gastrointestinal fistulae, the disparity between our results and the results reported by McPhayden and Dudrick remain to be explained, although they seem to be related with a different patient population. In fact, only 54.6% of the upper gastrointestinal and 38% of the large bowel fistulae in these author's series were related to surgical injury which, in this series, constituted etiology in 77% of the patients. It is well known that surgical complications lead often to complete or almost complete bowel disruption and to intraperitoneal abscess formation, precluding spontaneous fistula closure.

The proportion of surgical and conservative treatment of external gastrointestinal fistulae in recent series is shown in Table 7, and the figures of those who have incorporated parenteral nutrition or elemental diet to the general plan of treatment still indicate the necessity of surgical procedures in a great number of patients.

Parenteral nutrition has revolutionized the treatment of external gastrointestinal fistulae since it is no longer imperative that early operation be carried out to avoid irreparable metabolic and nutritional derangements and because it is now possible to get positive nitrogen balance, weight gain and wound healing in patients with a crippled gastrointestinal tract. The role of hyperalimentation, however, and the benefits of an extended conservative management should be estimated as limited in the presence of anatomical conditions, intraperitoneal sepsis, distal obstruction or persistent drainage after the recovery of the nutritional status. The establishment of these

criteria will improve, in our opinion, the comprehensive management of gastrointestinal fistulae.

References

1. Chapman, R., Foran, R. and Dunphy, J. E.: Management of Intestinal Fistulas. *Am. J. Surg.* **108**:157, 1964.
2. Dudrick, S. J., Wilmore, D. W., Vars, H. M. and Rhoads, J. E.: Long Term Total Parenteral Nutrition with Growth, Development and Positive Nitrogen Balance. *Surgery*, **64**: 134, 1968.
3. Edmunds, H., Jr., Williams, G. M. and Welch, C. E.: External Gastrointestinal Fistulae Arising from the Gastrointestinal Tract. *Ann. Surg.*, **152**:445, 1960.
4. Fischer, J. E., Foster, G. S., Abel, R. M., Abbott, W. M. and Ryan, J. A., Jr.: Hyperalimentation as Primary Therapy for Inflammatory Bowel Disease. *Am. J. Surg.*, **125**: 165, 1973.
5. Lorenzo, G. A. and Beal, J. M.: Management of External Small Bowel Fistulae. *Arch. Surg.*, **99**:394, 1969.
6. McPhayden, B. V., Jr. and Dudrick, S. J.: Management of Gastrointestinal Fistulae with Parenteral Hyperalimentation. *Surgery*, **74**:100, 1973.
7. Nassos, T. P. and Braasch, J. W.: External Small Bowel Fistulae. Current Treatment and Results. *Surg. Clin. North Am.*, **51**:687, 1971.
8. Roback, S. A., and Nicoloff, D. M.: High Output Enterocutaneous Fistulae of the Small Bowel. *Am. J. Surg.*, **123**: 317, 1972.
9. Ryan, J. A., Jr., Hopkins, C. H., Abbott, W. M. and Fischer, J. E.: Complications of Hyperalimentation. A Prospective Study of Two Hundred Consecutive Patients. *N. Engl. J. Med.*, **290**:757, 1974.
10. Sheldon, G. F., Gardiner, B. N., Way, L. W. and Dunphy, J. E.: Management of Gastrointestinal Fistulas. *Surg. Gynecol. Obstet.*, **113**:490, 1971.
11. Voitek, A. J., Echave, V., Brown, R. A., McArdle, A. H. and Gurd, F. N.: Elemental Diet in the Treatment of Fistulae of the Alimentary Tract. *Surg. Gynecol. Obstet.*, **137**:68, 1973.
12. Welch, C. E.: Intestinal Fistulas. *Am. Surg.*, **30**:631, 1964.
13. Welch, C. E. and Edmunds, L. H.: Gastrointestinal Fistulae. *Surg. Clin. North. Am.*, **42**:1311, 1962.